Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING FOR THE 2009 to 2012 MESON TEST BEAM PROGRAM

T-992

Tests of radiation-hard sensors for the SLHC

August 19, 2009

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1. INTRODUCTION

This memorandum is intended solely for the purpose of providing a work allocation for Fermi National Accelerator Laboratory and the participating universities and institutions. It reflects an arrangement that is currently satisfactory to the parties involved. It is recognized, however, that changing circumstances of the evolving research program may necessitate revisions. The parties agree to negotiate amendments to this memorandum to reflect such revisions.

This Memorandum of Understanding applies to the use of the FERMILAB Meson Test Beam Facility to study the performance of various sensors that are radiation hard and viable candidates for use in the innermost vertex detector for the SLHC environment. The tests will be carried out as a collaborative effort of Fermilab, and Colorado, Milano, Ohio State, Princeton, Purdue, Rutgers, Syracuse, and UCLA Universities.

At the SLHC, after 2500 pb^{-1} of data, the expected maximum fluence for the pixel region (<20 cm) will be 2.5×10^{16} cm^{-2}. To cope with this unprecedented radiation environment, there have been quite a few collaborations being formed at CERN to find possible solutions for vertex and tracking detectors at the SLHC. These include the RD42, RD49, and RD50 collaborations. A variety of solutions have been pursued. These include diamond sensors, 3D sensors, MCZ planar silicon detectors made from MCZ wafers, epitaxial, p-type silicon wafers and thin silicon detectors.

The experimenters wish to compare the performance of this wide variety of detectors in a test beam before and after irradiation. To do so, the experimenters plan to use the CMS pixel-based telescope currently being commissioned and constructed for the MTest facility. In particular, the experimenters are planning to study the charge collection efficiency of the irradiated and unirradiated devices and the spatial resolution as a function of the track incident angle. The experimenters will change the incident angle of the beam by moving the sensors, to investigate how the resolution varies with angle. Many physicists participating in this beam test are members of the RD42 and/or RD50 collaborations.

2. PERSONNEL AND INSTITUTIONS

Physicist in Charge and Group Leader: Simon Kwan (FERMILAB)
Lead Experimenter in charge of beam test: JC Yun (FERMILAB)
Fermilab liasion: Erik Ramberg (FERMILAB)

Note that the lead Experimenter in charge of the beam test could change for each test. We have identified the lead person (LP) for each group and depending on the tests, one of these people may take up the role of lead experimenter in charge of the beam test.
The members of the group which will take part in the installation, data taking activity, data analysis and dismantling at Fermilab are:

Simon Kwan (FERMILAB)
Umesh Joshi (FERMILAB)
Lorenzo Uplegger (FERMILAB)
Alan Prosser (FERMILAB)
Marcos Turqueti (FERMILAB)
Ryan Rivera (FERMILAB)
Ping Tan (FERMILAB)
JC Yun (FERMILAB)
Selcuk Cihangir (FERMILAB)
John Cumalat (Colorado -LP)
Kevin Stenson (Colorado)
Steve Wagner (Colorado)
Mauro Dinardo (Colorado)
Ashish Kumar (SUNY/LPC)
Zongru Wan (KSU/LPC)
Dan Marlow (Princeton -LP)
Daniela Bortoletto (Purdue -LP)
Gino Bolla (Purdue)
Steve Schnetzer (Rutgers -LP)
Robert Stone (Rutgers)
Ed Bartz (Rutgers)
Yuri Gershtein (Rutgers)
Rainer Wallny(UCLA -LP)
Luigi Moroni (Milano -LP)
Harris Kagan (OSU -LP)
Marina Artuso (Syracuse -LP)
Raymond Mountain (Syracuse)
Jianchun Wang (Syracuse)

3. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

3.1 LOCATION

3.1.1 The tests will take place in MT6-1A.

3.1.2 Lab space within or outside MTest shall be provided for pre-testing the detectors and making repairs as necessary. This shall include a few ~30"x72" work surfaces in a low dust environment equipped with ESD-safe surfaces and grounding and lights.

3.1.3 Office space including three or more desks and network connectivity will be provided for the duration of this test experiment.

3.2 BEAM

3.2.1 Type of Beam Needed: 120 GeV proton beam

3.2.2 Intensity Needed: 10-100k particles/ (4s spill)
Beam Size Needed: ~ 10 cm^2

3.3 EXPERIMENTAL CONDITIONS

3.3.1 Provision will be made by Fermilab for the devices under test (including the largest pixel sensor which measures roughly 2 cm by 8 cm) to be rotated with respect to the beam direction.

3.3.2 A pixel telescope for the test beam line is required. Fermilab will provide this telescope and appropriate DAQ support including computer, while the experimenters will offer the manpower to operate the telescope.

3.3.3 The test environment shall be humidity-controlled, preferably with the test devices in a dry nitrogen atmosphere. The experiment will be designed to be an ODH class 0 environment.

3.3.4 There shall be refrigeration capability so that the detectors under test can be operated at -10^{o} C, the expected operating temperature of vertex detectors for the SLHC experiments. Given the power consumption of the pixel readout chips, a cooling capacity of ~ 10W at -30C (temperature of the cooling interface) should be foreseen.

3.3.5 Fermilab will provide the DAQ and slow control computers for the telescope, trigger counters and associated readout electronics.

3.3.6 Fermilab will provide 500 Gbytes of space on a managed disk server that the experimenters will use for short-term backup of test beam data.

3.4 ELECTRONICS:

The pixel telescope will be read out through a custom DAQ system. A gigabit Ethernet board will be used to route the data to an online computer which will be connected to a Fermilab

server via internet. The readout boards will be located close to the detector in the hut. The detectors themselves may be operated up to ~1000 V. No exposed HV parts will be present.

Since the experimenters will be testing different sensors (material, strips, pixels etc), while they will try to have as much as possible common readout electronics and DAQ system, it is possible that there will be a separate trigger, readout, and DAQ system for a particular set of tests. This will be provided by the participating institutes.

3.5 SCHEDULE:

The time schedule is primarily dictated by the availability of the completed pixel telescope in the test beam and the detectors under test. As this is expected to be completed in the Fall of 2009, the experimenters envisage running their first tests at that time. Since the plan is to test the detector before and after irradiation and different types of detector will be tested, the test program will last three years. The experimenters request beam time during the next three years. Each year, the experimenters will request up to three slots of beam time, each of three weeks duration.

4. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

The personnel from the participating institutes will provide and set-up equipment on the beam line under the Fermilab Particle Physics Division guidance and supervision, provide the DAQ and slow control systems if needed, provide run coordination and funding for its personnel for the beam test.

5 RESPONSIBILITIES BY INSTITUTION - FERMILAB

5.1 FERMILAB ACCELERATOR DIVISION:

5.1.1 Use of MTest beam as outlined in Section 3.

5.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.

5.1.3 Reasonable access to the experimenters' equipment in the test beam.

5.1.4 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR).

5.1.5 Position and focus of the beam on the experimental devices under test will be under control of MCR. Control of secondary devices that provide these functions will be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

5.2 FERMILAB PARTICLE PHYSICS DIVISION

5.2.1 The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer.

5.2.2 PPD will maintain scintillation counters that are part of the Meson Test Beam Facility.

5.2.3 PPD will provide on-call LINUX DAQ computing support for the facility and experiment computers during normal working hours.
5.2.4 PPD will commission and maintain the Meson Test Beam Facility pixel telescope and assist in coordinating it with the experimenters DAQ.
5.2.5 PPD personnel will assist in modify the Device under test housing if needed to allow it to be used any particular detector to be tested as detailed in 3.3
5.2.6 PPD will provide office and lab space as detailed in 3.1.

5.3 FERMILAB COMPUTING DIVISION
5.3.1 Ethernet and printer will be available in the counting house.
5.3.2 CD will provide on-call LINUX DAQ computing support for the facility and experiment computers during normal working hours.
5.3.3 CD/ESE will commission and maintain the Meson Test Beam Facility pixel telescope and assist in supporting it with the experimenters' DAQ if needed.
5.3.4 Connection to beams control console and remote logging (ACNET) should be made available in the counting house.
5.3.5 CD will provide access to 500 Gb data storage on a centrally backed-up server for the duration of the beam test.

5.4 FERMILAB ES&H SECTION

Assistance with safety reviews.

6 SUMMARY OF COSTS

Source of Funds [$K]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Particle Physics Division	$0k	$1K	3
Accelerator Division	0	0	1
Computing Division	0	0	1
Totals Fermilab	0k	$1K	5
Totals Non-Fermilab			

SPECIAL CONSIDERATIONS

7.1 The responsibilities of the PI of the various groups and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters": (http://www.fnal.gov/directorate/documents/index.html). The Physicist in charge agrees to those responsibilities and to follow the described procedures.

7.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Physicist in Charge will follow that those procedures will be followed for all the tests in a timely manner, as well as any other requirements put forth by the division's safety officer and and follow all procedures in the PPD Operating Manual.

7.3 The Physicist in charge will ensure that at least one person will be present at the Meson Test Beam Facility whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

7.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

7.5 All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

7.6 The Physicist in charge will undertake to ensure that no PREP or computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Division management. They also undertake to ensure that no modifications of PREP equipment take place without the knowledge and consent of the Computing Division management.

7.7 The Physicist in charge will be responsible for maintaining and repairing both the electronics and the computing hardware supplied by them for the experiment. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

7.8 At the completion of the experiment:

7.8.1 The physicist in charge is responsible for the return of all PREP equipment, computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the PI of the university groups participating in the test will be required to furnish, in writing, an explanation for any non-return.

7.8.2 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ES&H requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters.

7.8.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied.

7.9 An experimenter will be available to report on the test beam effort at a Fermilab All Experimenters Meeting.

SIGNATURES

_____ / / 2009
Simon Kwan, FERMILAB

_____ / / 2009
Michael Lindgren, Particle Physics Division

_____ / / 2009
Roger Dixon, Accelerator Division

_____ / / 2009
Peter Cooper, Computing Division

_____ / / 2009
Nancy Grossman, ES&H Section

_____ / /2009
Greg Bock, Associate Director, Fermilab

_____ / /2009
Stephen Holmes, Associate Director, Fermilab

7 APPENDIX I - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need have been checked

Cryogenics		Electrical Equipment		Hazardous/Toxic Materials	
	Beam line magnets		Cryo/Electrical devices		List hazardous/toxic materials
	Analysis magnets		capacitor banks		planned for use in a beam line or experimental enclosure:
	Target		high voltage		
	Bubble chamber		exposed equipment over 50 V		
Pressure Vessels		**Flammable Gases or Liquids**			
	inside diameter	Type:			
	operating pressure	Flow rate:			
	window material	Capacity:			
	window thickness	**Radioactive Sources**			
Vacuum Vessels			permanent installation	**Target Materials**	
	inside diameter	**X**	temporary use		Beryllium (Be)
	operating pressure	Type:			Lithium (Li)
	window material	Strength:			Mercury (Hg)
	window thickness	**Hazardous Chemicals**			Lead (Pb)
Lasers			Cyanide plating materials		Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
	Temporary installation		PCBs		Other
	Calibration		Methane	**Mechanical Structures**	
	Alignment		TMAE		Lifting devices
type:			TEA	**X**	Motion controllers
Wattage:			photographic developers		scaffolding/elevated platforms
class:			Other: Activated Water?		Others